Volume 45 DECEMBER, 1959 *Number 12*

Lubrication

A Technical Publication Devoted to the Selection and Use of Lubricants

This Issue

PRINTING
LUBRICATION

Ten-Year Index

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LUBRICATION

A TECHNICAL PUBLICATION DEVOTED TO THE SELECTION AND USE OF LUBRICANTS

Published by
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PRINTING LUBRICATION

THE above title has an intentional *double entendre* since this issue will describe the lubrication of printing equipment in general but especially the *letterpress* equipment used to produce this very publication in the United States.

As indicated in Figure 1, this forty-eight-year-old publication has been of international scope for many years because the primary United States edition is also translated into Portuguese, Spanish, French and German and printed abroad for distribution throughout the free world.[1] Since the equipment being used to produce the non-English editions is not known, this issue will of necessity be confined to the description and lubrication of that used in the United States; however, the general principles involved are believed applicable to all.

When John Gutenberg printed a Bible nearly five centuries ago, he originated the flat-bed letterpress method and adapted the crude wine-press for his purpose. It probably received no lubrication. With his hand-operated press, speed was impossible and since breakdowns were only minor annoyances that could be repaired cheaply and leisurely, lubrication and preventive maintenance were unprofitable. Five hundred years has vastly changed this picture and in fact the major change has occurred within the last hundred. Until the beginning of the last century only 200 impressions (copies) an hour was practicable and only a husky pressman could sustain that. The first successful rotary press increased this output fivefold. Today's precision flat-bed press can produce as many as 4000 copies of this publication every hour while a modern rotary web newspaper press turns out more than 100,000 newspapers per hour.

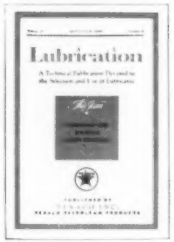
The petroleum industry has played an important part in this perfection of the modern printing press. Petroleum oils are used in preparing the special inks; without petroleum lubricating oils and greases to protect its myriad finely-built bearings, gears, slides and cams, the modern press could not function with its unbelievable speed and precision.

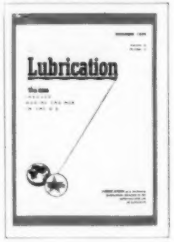
As will be described later in greater detail, this publication is printed by flat-bed letterpress method on separate sheets of paper which are then folded, stitched (stapled) and trimmed to provide any multiple of four pages.

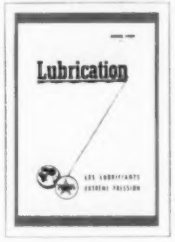
TYPESETTING

Letterpress printing requires preliminary typesetting and the preparation of illustration "cuts". Except for the few very large letters used in titles and advertisements (which are cast and hand-set as individual letters), the bulk of the type used in letterpress work is machine set as full line "slugs" like those shown in Figure 2. The highly ingenious Linotype machine shown in Figure 3 produces these slugs, and the heart of this machine lies in its interchangeable magazines, each of which contains a *font* of as many as several hundred *matrices* ("mats") of a given type face like the single one

[1] It is both difficult and expensive to distribute any issue very far outside the country in which it is printed. In other words only the primary English issue is usually obtainable in the United States and Canada.



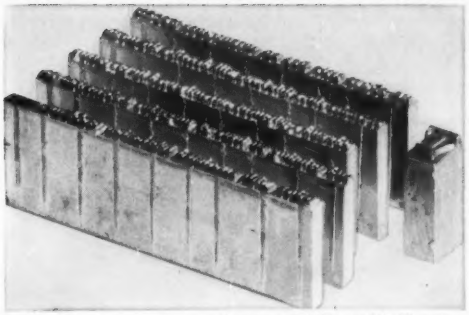




Edition Language	English (Primary Edition)	Portuguese	Spanish	English (European Edition)	French	German
Title	Lubrication	Lubrificação	Lubricación	Lubrication	Lubrication	Moderne Schmierung
Sponsor	Texaco Inc. 135 E. 42nd St., N. Y. 17, N. Y.	Texaco (Brasil) Inc. Rua do Passeio, 62 Rio de Janiero, Brasil	Texaco S.A. Benjamin Franklin 233, Mexico D.F., Mexico	Caltex West Co. 380 Madison Ave., N. Y. 17, N. Y.	Caltex S.A.F. 39 rue Cambon, Paris, France	Caltex Tank-Kraft, Mineralöl-GmbH. Brahmsstrasse 3, Hanover, Germany
Date on 1st Issue Distributed	Aug. 1911	Before Oct. 1918 Reinstated Jan. 1957	May 1948	July 1946	Sept. 1920	Aug. 1958
Frequency of Issue	Monthly	Monthly	Monthly	Monthly	Quarterly[a]	Quarterly
Total No. of Issues thru June 1959	522	30 since Jan. 1957	134	162	258	5
No. of copies printed of June 1959 Issue	62,600[b]	2500	3300	23,500	4310[c]	2700
Present Printer	Salley & Collins, Inc. 305 E. 45th St., N. Y. 17, N. Y.	Grafica Barbero S.A. Rio de Janeiro Brasil	Offset Lusan, S.A. 5 de Febrero No 469, Mexico 8, D.F. Mexico	Salley & Collins, Inc. 305 E. 45th St., N. Y. 17, N. Y.	S.C.I.P. Moriame 61, Faubourg Poissonniere, Paris 9, France	Buchdruckerei Otto K.G., Stiftstrasse 13, Hanover, Germany

[a]Monthly until 1939, none from 1939 to 1945, informally and irregularly from 1945 to 1952, now quarterly.
[b]Included 6100 for Texaco Canada Ltd.
[c]Included 1200 for Texaco in West Africa.

Figure 1 — The International aspects of magazine LUBRICATION.



Courtesy of Salley and Collins, Inc.

Figure 2 — Five linotype slugs and the separate initial T similar to those used in printing the very first paragraph of this article.

shown in Figure 4. If the reader will closely examine the nearest edge of this particular matrix he will detect two tiny upside-down permanent molds which the Linotype uses and reuses to produce several hundred thousand capital M letters of either the vertical roman or slanting italic styles. By merely pressing the appropriate key in his 90-character keyboard, the Linotype operator selects each desired letter matrix in order until he has almost filled the desired "line of type". (In this publication a line of text averages 50 characters of the Garamond type face in 10 point size). The machine automatically assembles the matrices in the chosen order, spreads them apart with intervening wedge-shaped *spacebands* to *justify* (fill out) the full line, and uses the assembly as one side of a slug mold which is then filled under pressure with molten type metal. The resultant slug solidifies almost instantly, is automatically removed from its mold, trimmed and stacked in a "galley" (tray). At the same time the matrices composing this mold are disassembled, sorted out by the complex system of small notches in their Vee tops and each returned to its proper slot in the machine's magazine.

Such a condensed description of the intricate Linotype machine must not mislead the reader into thinking that this clever machine also maintains itself. As the second sentence of the Linotype manual so correctly states "In this (maintenance) plan, proper lubrication is the most important single factor". Anyone responsible for the care of these machines is therefore advised to procure and carefully follow its well-written maintenance manual which locates and gives detailed instructions on the lubrication by hand of its more than 150 different lubrication points. The latest machines eliminate the periodic lubrication of eight of these points by employing oilite bearings; most of the remainder require either a periodic drop or two of an SAE 20 or two lighter special machine oils, while ten screw type grease cups need filling and an occasional turn. With regard to lubrication intervals the manufacturer points out "The widely varying conditions under which Linotypes are operated with respect to running time, cleanliness and climate combine to make it a problem best solved locally through the exercise of simple mechanical judgment. It should be sufficient to point out that the constantly moving parts call for more frequent attention than those which only contact when the machine makes its periodic cycles."

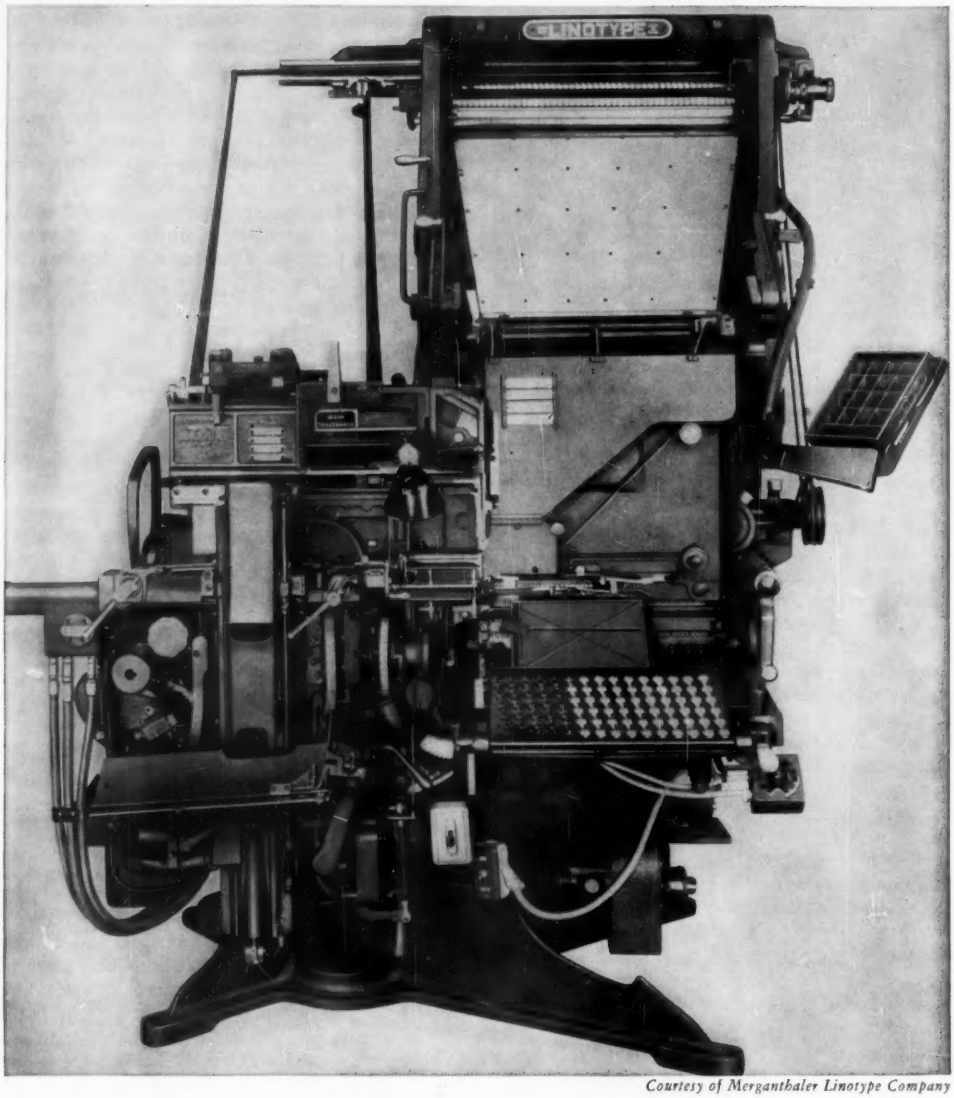
PHOTOENGRAVING

Without requoting the overworked Chinese adage, it must be admitted that proper illustrations can convey certain types of information more precisely and more concisely than words, hence a combination of illustrations and words is usually the most effective. The early invention of printing made it possible to reproduce and disseminate unlimited copies of words; the parallel invention of a practical method of accurately reproducing pictures first had to await the invention of the camera, then the equally difficult invention of making multiple true copies of its pictures. This second invention was made only seventy years ago.

The simplest type of illustration from the reproduction standpoint is a *line cut,* or line engraving that is a curve, drawing, chart or silhouette which is composed solely of black lines or areas on the white background provided by the paper. In other words every detail is either pure black or pure white and there are no gradations or shades or greys between these two extremes.

The *original artwork* for such an illustration is merely photographed to the desired finished size in a precision photo-engraving camera like that pictured in Figure 5. Before being deceived by the apparent simplicity of this camera, the reader is advised that it can expose a plate or film measuring 22 by 28 inches, consequently it is a large expensive precision instrument approximately fifteen feet long and six feet high with the right hand or plate portion built into the wall of a large dark room. The camera is readily adjusted to produce a film image that is either smaller ("reduced"), the same size, or larger ("blown up") than the original artwork.

After exposure and developing, the thin gelatine coating of the plate or film (which contains the negative image) is carefully stripped (peeled) from its glass or acetate backing, turned over and placed in close contact with another light-sensitive coating on a flat zinc or copper sheet. When this plate with its film overlay is exposed to a strong light and photographically developed, it becomes a



Courtesy of Merganthaler Linotype Company

Figure 3 — Linotype typesetting machine.

photographic positive on metal in which the black portions of the original artwork are faithfully reproduced but with an insoluble protective coating. Contrariwise all the white portions of the original artwork are reproduced as bare unprotected metal. As a consequence the metal plate can now be exposed to a succession of acid etches (or "bites") which dissolve away and make depressions out of the white parts without affecting the black. Thus if the surface or black parts of the resultant photoengraving are coated lightly but evenly with black ink and pressed firmly against white paper, the impression on the paper will be an absolutely accurate scale reproduction of the original artwork, and can be used to make innumerable copies of it. The necessary separate plate for each additional color in a line cut is made by inserting a color filter in the camera which will pass only the desired color. In effect, the photoengraving of a line cut is a modern, more accurate, and less expensive substi-

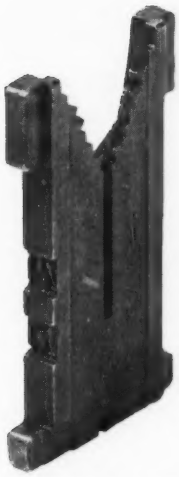


Figure 4 — Linotype matrix for capital letter M.

tute for the laborious and scarce artistry of the hand engraver.

Half Tones

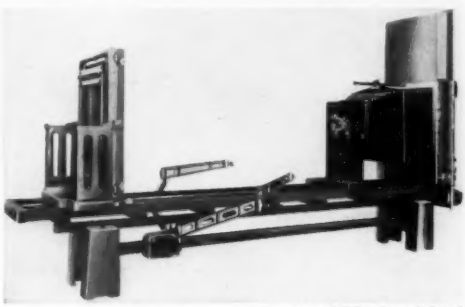
Unlike the simple line cuts just described which are composed of either pure black or pure white, a photograph of a person or object contains in addition an infinite number of greys of varying tones. The human eye is said to be capable of distinguishing among at least 2500 greys alone, consequently an accurate reproduction of a "black and white" photograph must either duplicate these greys or at least fool the eye into apparently seeing them. Figure 6 represents an attempt to reproduce an excellent photograph of a jet engine in black and white without any intermediate tones: the resultant blob is obviously useless. Only a copper or steel plate engraver could even begin to suggest fine tones and tone gradations with the shadings of his artistry and none but the simplest of pictures could be attempted with days or weeks required to accomplish each one. The profusion of excellent pictures in modern magazines and newspapers became possible only with the invention in 1888 of the "half tone screen". Such a "screen" consists of two pieces of plate (flat) glass, each "ruled" (actually etched) with fine equally spaced parallel lines, then cemented together with their lines at right angles so as to form tiny squares. When placed a short but precisely controlled distance in front of the photographic plate in the photoengraving camera, such a screen has the almost miraculous ability to break up the continuous tones of the object photograph into tiny squares or "dots" which vary in size (and therefore in apparent blackness) to correspond to the blackness of the minute area in the object photo which each dot faithfully represents. The distance between the lines on the screen determines the *maximum* size of the dots, their center to center spacing, and of course whether or not they are individually visible to the naked eye. Furthermore the nature of the paper, the ink and the press determine the fineness of the screen that can be used. For example rough textured, unfilled ink-absorbent newspaper or "pulp" prevents use of a screen finer than fifty to sixty lines per inch, consequently the individual dots are readily seen, the eye is only partly fooled, and the apparent gradation in tone from black to white is not wholly satisfactory.

A screen of 120 lines is used for illustrations which are to be reproduced on hard-surfaced non-absorbent coated "slick" paper like that used in this publication. Screens as fine as 200 lines have been used for especially perfect letterpress reproduction and 400 lines for unusual offset art reproduction. The term "half tone" is therefore a gross underestimate; the minimum number of tones available between black and white is at least equal to the number of lines on the screen and more probably to the square of that number.

Figure 7 utilized the identical artwork for Figure 6 but a 120-mesh screen was inserted in front of the photoengraving camera's plate to form the magic half tone dots: the improvement over Figure 6 is dramatic. Any reader who still does not believe that the apparently smooth changes of tone in Figure 7 are actually the effect of something more than 180,000 tiny dots is invited to either reach for his own magnifier or to accept the photomicrograph at the lower right of Figure 7 which magnifies a small part of one blade in the number two turbine just above it on the main figure.

Process Color

From the foregoing the reader will appreciate some of the problems that have been met and solved in the reproduction of "simple" black and



Courtesy of The Consolidated International Equipment & Supply Company

Figure 5 — Twenty-four inch Consolidated Precision Color Camera; maximum plate or film size is actually 22x28 inches.

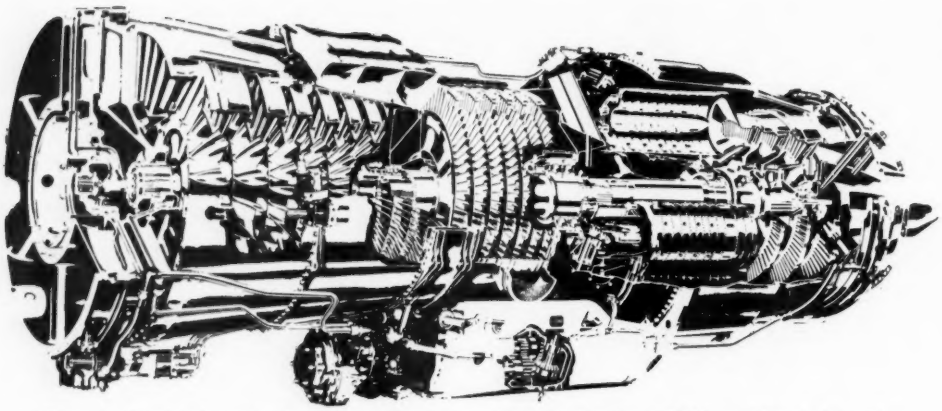
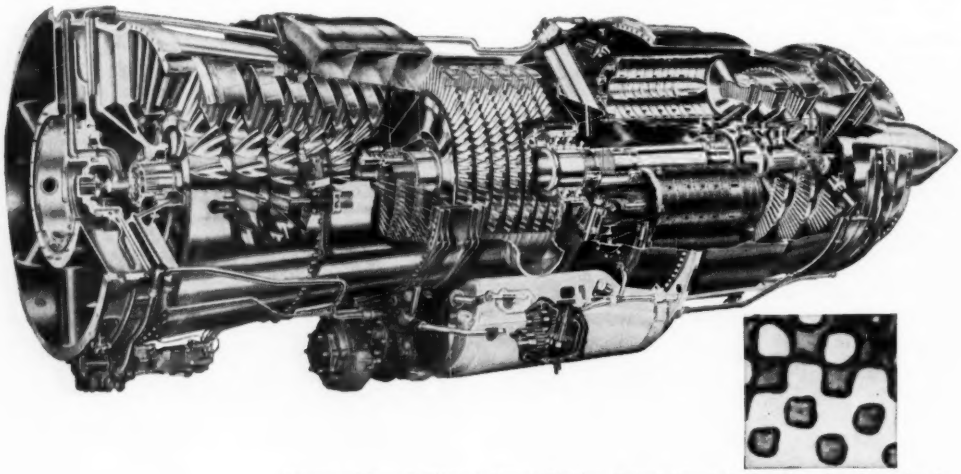


Figure 6 — Attempted reproduction without a screen of a photograph of the Pratt & Whitney JT-3 turbo jet engine.

white originals. Colored originals are many times more difficult and expensive yet they must occasionally be reproduced in this publication for such strictly utilitarian purposes as transmitting information on the color and texture of greases, the identification of fretting corrosion, the effectiveness of rust preventives, and anywhere that true color is necessary. "Process color" is the term used to describe the methods used in such instances which are much more complex than the previously-described application of solid *opaque* colors to simple line cuts. Process color is a three or four dimensional extension of the basic half tone process in that the reproduction is composed of dots of three or preferably four different colors and is subject to the infinite interplay among them. Since colored dots may be overlayed it is necessary for other than the first color down to use transparent inks in the reflected primary colors of yellow, red, blue and black which are frequently overprinted in that order. Corresponding color separation plates are obtained by using violet, green, orange and yellow filters with the screens angled from the left horizontal by 60°, 75°, 105° and 145° respectively to avoid unpleasant moiré effects. Since filters are not perfect the camera tends to overemphasize certain color combinations which are reflected in the color separation plates, and the photoengraver must sometimes perform considerable hand work in burnishing (to emphasize) or re-etching (to



Courtesy of Pratt & Whitney Aircraft Division, United Aircraft Corp. and Sterling Engraving Co.

Figure 7 — The identical artwork for Figure 6 reproduced with a 120-line half tone screen. Insert photo magnifies the half tone dots composing a small portion of one blade in the number two turbine.

minimize) one or more plates to restore color balance that exactly matches the original, – the ultimate achievement of a true reproduction. Numerous proofs are "pulled" by the engraver from each color plate and the whole combination, preferably using the same paper, inks and color sequence as will be ultimately used by the printer since these factors will also affect the final result that is set before the reader.

ELECTROTYPES

By this time the reader would be justified in assuming that with type and photoengraving cuts now available, the issue has been "put to bed", i.e. ready for the press. Such is not the case however because printing is rarely performed with the actual type and cuts but instead by electrotype plates of each page. The type and cuts for each page are first assembled and clamped tightly ("locked up") into a heavy rigid *chase* (metal frame). An accurate impression of the type form is then made in plastic or wax which is coated with a thin layer of metallic silver or graphite (to give an electrically conductive surface), then nickel plated to obtain a hard wearing surface and finally copper plated for several hours to obtain a copper thickness of about 0.018 inches.

The copper surface adjacent to the plastic is an unbelievably exact reproduction of the original type and cuts, including the latter's tiny dots, and becomes the printing surface of the plate. If the plate is to be used in a flat-bed press it is backed with a heavy layer of metallic lead and carefully adjusted to flatness. If a rotary press is to be used the thin copper is readily bent to conform to the cylinder's radius, then backed.

PRESS LUBRICATION REQUIREMENTS

Almost regardless of its specific type or purpose the modern printing press is a precision mechanism of exceedingly complex construction which employs an amazing variety of gears of all types, cams, chains, ratchets, rollers, levers, links, guides or ways, vacuum and pressure air pumps, and of course the many types of plain and anti-friction bearings that are needed to support and keep these mechanisms in precise alignment under heavy loads and high speeds. The failure of a single part among the thousands is quite enough to stop the entire press; the resultant "down time" is not only ruinous to the tightly coordinated production schedule of the modern press shop and conducive to customer dissatisfaction, but overhead charges on such a large capital investment accumulate at a frightening rate.

To be profitable, presses must be kept running; the surest guarantee of success is correct lubrication with its six "rights" – the right *type* and right *quality* of lubricant in the right *condition* and the right *amount* at the right *place* and at the right *time*. Every dollar invested in good lubrication provides the cheapest possible protection against expensive wear and failure. The price of good lubrication is infinitesimal when compared to the other costs which it can prevent. Attempts to "save money" by slighting any of the six lubrication "rights" can be expensive indeed!

Right Type and Quality

Much confusion, uncertainty of lubrication and unnecessary expense has resulted from the too common fault of stocking and trying to use a greater variety of lubricants than is actually required by the machines. Page 164 presents a simplified lubrication plan requiring a minimum number of lubricant types of adequate quality which has resulted in very substantial monetary and other savings wherever it has been adapted to a specific shop by a trained lubrication engineer. The basic principle of the plan is that a lubricant of adequate quality can do many jobs well, whereas the opposite is never true. The versatility alone of a high quality lubricant more than compensates for its small additional cost.

Right Condition

The best of lubricants and their subsequent ability to lubricate are too often destroyed through improper storage and handling, a subject which is thoroughly discussed in a previous issue[2] of this publication. Through its reduction of lubricant types and confusion, the simplified lubrication plan greatly assists in the maintenance of right condition.

Right Amount, Right Place, Right Time

The best of lubricants in the best of condition are still ineffective unless sure provision is made to apply them in the right amount at the right place and the right time. Equipment manufacturers are well aware of these three final vital steps in the lubrication process and are increasingly building specialized and often automatic lubrication systems into their equipment which are designed to accomplish these steps with minimum human effort and the attendant possibility of human error. Hand oiling, for example, of the more complex machines has largely given way to the centralized system, while previously open mechanisms are now housed wherever practicable to permit circulating or bath lubrication with minimum leakage.

LUBRICATION METHODS

Following are brief descriptions[3] of the several types of lubrication systems that are being used or are applicable to printing machinery.

[2] September 1955.
[3] See Aug. 1954, Aug. 1957 and Nov. 1957 issues for complete coverage.

SIMPLIFIED LUBRICATION PLAN FOR PRINTING AND ASSOCIATED PUBLISHING MACHINERY

Applicable to rotary, flat bed and platen presses (web and sheet fed, letterpress and offset); paper feeders, folders, cutters, gatherers, stitchers, coverers; Linotype, Monotype, Autoplate machines; plate curvers, routers, saws, planers.

Mechanism	Lubricant
Ball, roller, needle bearings; oil tight housings, bath or circulating system	R_c
Plain bearings; oil tight housings, bath or circulating system	R_c or R_f
Plain bearings; exposed, oil lubricated	R_c
Hydraulic systems	R_a
Vacuum-air pumps	R_c
Oil Mist Lubricators	R_c
P.I.V. (variable speed) drives	R_k
Roller chains	R_c
Electric motors, oil lubricated	R_c
Heavily loaded spiral, worm, and hypoid gearing; oil tight housings, bath or circulating system	M_3 or M_1 or M_6
Cams, inclosed, oil lubricated	M_3 or R_c
Heavily loaded spur or bevel gearing, exposed	C
Lightly loaded gearing, exposed	G or C
Plain bearings, exposed; grease lubricated	G
Ball, roller, needle bearings; exposed, grease lubricated	G
Cams, exposed, grease lubricated	G
Electric motors, grease lubricated	G
Pressure gun fittings	G
Unused plate & roller surfaces (when running narrow forms)	G

Lubricant	Description	Approximate Oil Viscosity, SUS @ 100 or NLGI Grease Grade
R_a	Rust and oxidation inhibited turbine and hydraulic oil	**150** (SAE 10W)
R_c	ditto	**300** (SAE 20-20W)
R_f	ditto	**650** (SAE 30, App. SAE 90)
R_k	ditto	**2000** (SAE 140)
M_1	Oxidation, foam and rust preventive, lead soap, extreme pressure oil	**325**
M_3	ditto	**1325**
M_6	ditto	**3350**
C	Extremely adhesive, extreme pressure, heavy, rust preventive oil with volatile solvent for easy application	Application: **2500** Operation: **2000** @ 210°F
G	Ball, roller, and plain bearing grease, oxidation resistant, wide temperature range, sodium-calcium or lithium soaps with 300-500 SUS @ 100°F. oil	NLGI #**2**

Oil Holes, Cups and Baths

Oil holes are the simplest, least expensive and frequently the only practicable means in a compact mechanism of lubricating a large number of lightly-loaded slow moving bearings. Even with the aid of a lubrication diagram and the good practice of counting holes some are easily missed. Oil cups provide gravity feed with some measure of reserve lubricant for critical and high-consumption bearings. Some cups have filter felts to prevent entrance of dirt; the most refined have adjustable feed valves which can also be turned off when the machine is not running. The obvious disadvantage of oil holes and oil cups is their complete dependency on the conscientiousness of the operator. The oil bath is an oil-tight reservoir in which the operating mechanisms either dip or are completely submerged. Lubricant loss is negligible; however, an uncovered bath tends to collect trash like airborne paper fibre and should be occasionally drained, cleaned and refilled.

Wick Feed Oilers

The wick feed oiler consists of an oil cup, but with its reservoir separated from the delivery pipe to prevent any gravity feed. One or more wicks inserted in the delivery pipe and dipping into the reservoir provide a regulated feed of clean (wick filtered) oil through capillary action of the wick. Shut-off cocks are sometimes provided to be turned *off* during idle machine periods, however these, like any manual device, are subject to lapses of the operator's memory, since he can as easily forget to turn them *on*.

Centralized Hand Pressure Oil

Such a system consists of an oil reservoir and a manually operated or controlled pump connected by pressure tubing, and frequently metering orifices, to the bearings to be lubricated. While the frequency of lubrication must still depend upon the press operator, the centralization and pressure application characteristics of the system encourage much better performance than widely separated and often inaccessible oil holes and cups.

Mechanical Forced Oil Feed

In effect this is an extension of the previous system in that the oil pump is driven by the press itself, the lubrication interval is therefore regulated and the operator is only required to keep the oil reservoir full. Some systems even prevent this possible neglect by providing a float-operated switch which will shut down the whole press whenever oil supply is inadequate. Finally, most of these systems provide for the all important regulation of the amount of oil forced to the bearing.

Oil Mist Lubrication

This system uses filtered compressed air to finely atomize or "fog" the oil which is then air-borne in tubing to the lubrication points where (if desired) special fittings may be provided which coalesce the mist back into oil drops.

Circulating Oil Systems

The larger high speed presses generally inclose all possible operating mechanisms in oil tight casings or housings so that the mechanisms can be supplied through tubes with considerable quantities of filtered oil under pressure from one or more pumps. The surplus oil in each housing is returned to a main supply tank where it is settled, deaerated, filtered, cooled if necessary and then recirculated. Thus in addition to providing lubrication, the circulating oil also acts as a cleaner and coolant.

Grease Cups and Pressure Fittings

Grease may be used as a lubricant wherever the design of the mechanism prevents retention of oil, or where a combination of heavy load and low speed prevents the formation of a hydrodynamic oil film. The commonest method of applying grease is through a grease cup which should be turned down at intervals by hand, then refilled as required with the attendant difficulty, mess and likelihood of contamination. Unless it is naturally quite fluid or the bearing overheats enough to melt it, the grease may not reach a bearing unless forced into it by turning the threaded grease cup cap. An improved type of grease cup uses a spring-loaded follower to exert a constant pressure on the grease together with a grease pressure gun fitting to replenish it. The protruding follower stem of such a cup provides a visual indication of both its feeding rate and the amount of grease remaining. The modern pressure fitting uses the much higher pressures available in a pressure grease gun, and usually contains a check valve to prevent back flow when the gun is disconnected.

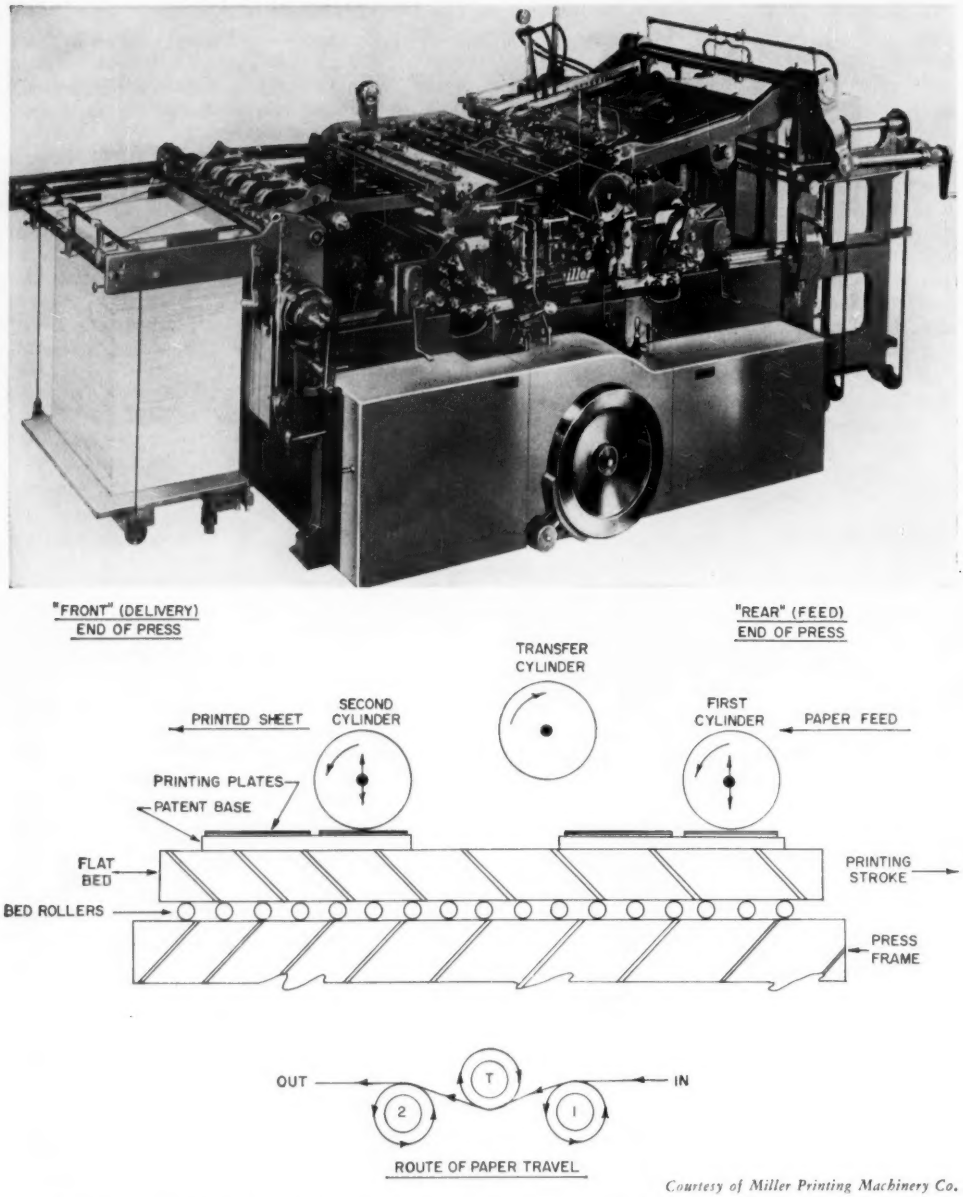
Mechanical Forced Grease Feed

Several systems are available which automatically measure the desired amount of grease, then force it either mechanically or manually under high pressure to each bearing in turn through high pressure tubing. Other applications of such systems are fully described in previous issues of this publication.[4]

PRESS OPERATION AND LUBRICATION

The two most common methods of printing – "letterpress" and "offset" – employ quite different principles. In the letterpress method, the top sur-

[4] September 1950 and August 1957.



Courtesy of Miller Printing Machinery Co.

Figure 8 — Miller TW 21x28 two-color flat bed letterpress with schematic illustrating its basic operating principles.

face of the rigid deeply-relieved type, photoengraving or electrotype is inked, then pressed ("letter press") very firmly against the paper (or vice versa). In offset printing however, the thin flexible metal plate bears a photographic image which has negligible physical relief but is chemically pretreated so as to be ink receptive. The water-receptive nonprinting areas are kept wet by a system of rollers known as the dampeners and therefore repel the oil-base ink. In offset printing only enough pressure

is required to insure intimate contact and transfer of ink from plate to blanket and blanket to paper. Both methods can overprint any number of colors on the same piece of paper, and both require a separate plate ("color separation") for each color including black. Both methods can utilize either separate sheets or a continuous roll ("web") of paper and conceivably either flat or curved plates, however a flat offset plate is now uncommon.

Flat Bed Letterpress

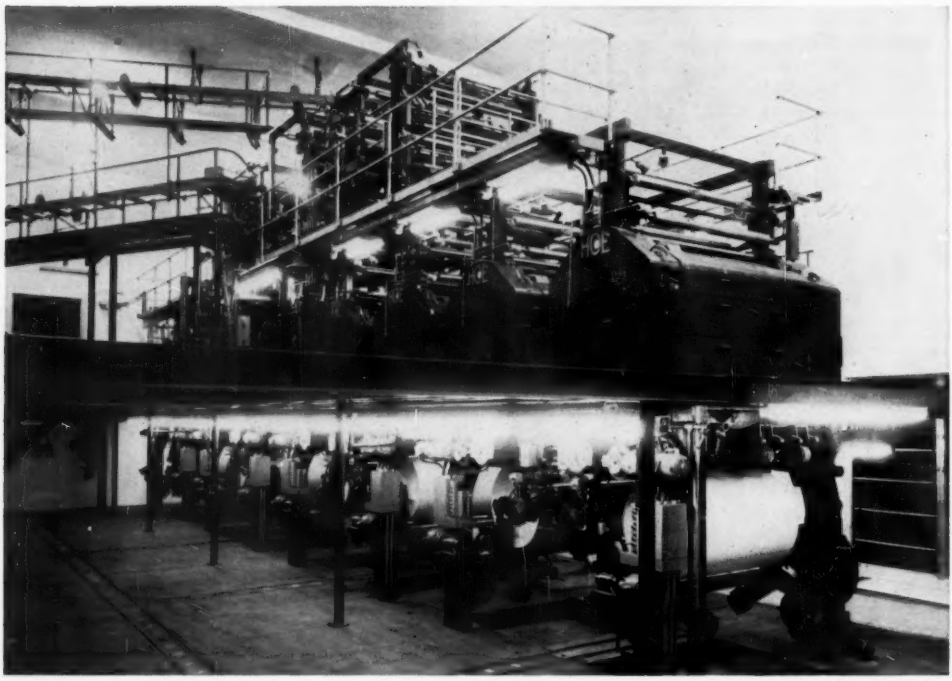
This type of press, illustrated in Figure 8, is used to print this publication. It derives its name from the fact that the printing elements (electrotype pages for this publication) are fastened to a *patent base* mounted on the *flat bed* of the press which is reciprocated horizontally. To enable two colors to be printed during a single passage of each paper sheet, this press is provided with two *cylinders* which carry the sheet and roll it under heavy pressure against the electrotype plates as diagrammed schematically in the lower part of Figure 8. Each of the plate sets corresponding to the two cylinders is provided with its own inker units consisting of an ink fountain and complex system of ink rollers. As implied by its name the central *transfer cylinder* takes the paper sheet from cylinder #1 on the reader's right, turns it over and passes it to cylinder #2 which makes the second printing impression on the same side of the paper. All three cylinders rotate steadily in the directions indicated, but the outer printing cylinders also oscillate up and down with such timing that they contact and roll on the printing plates only when the flat bed is moving to the rear (the reader's right). All three cylinders are hollow and contain cam-operated finger-like *grippers* which close at the precise moment to grasp the leading edge of the paper and to wrap it smoothly around them. The automatic sheet feed mechanism at the rear of the press employs compressed air to *wind* (separate) the top sheet, timed vacuum-cupped fingers to move it onto the *feed board,* an automatic sheet caliper which stops the press if two sheets are fed, and a series of timed levers and stops which locate the sheet precisely for grasp by the first cylinders grippers.

Stripper Fingers and *shooflies* remove the printed sheet from the second cylinder and insert it between the upper and lower *delivery tapes* which are driven at high speed and not only convey the sheet to the delivery pile but prevent it from buckling en route. A series of open gas flames on the underside of the sheet has negligible ink-drying effect, but does ionize the air and discharge static electricity in the sheet which would otherwise prevent it from stacking. Each sheet is also subjected to a timed and finely atomized puff of "anti offset fluid" which prevents the freshly-printed side from offset or transfer printing on the underside of the following sheet.

In spite of the abbreviation of the foregoing description it is hoped that the reader will appreciate that such a press is an exceedingly complex heavily-loaded high-speed mechanism and that all of its parts must perform their functions completely with extraordinary accuracy in exact sequence at the precise instant. To insure continuance of the performance that he has built into the press, the manufacturer has issued very complete instructions on mechanical adjustments, periodic maintenance and lubrication. The most critical lubrication points are automatically lubricated with heavy oil (about 650 SUS @ 100°F) by means of a forced feed oiler which will stop the press if oil supply is low. Several oil cups, oil holes and wick feeds are hand-oiled. Bed roller tracks are lubricated by means of their own oil reservoir which should be cleaned and refilled about every 500,000 impressions with the above oil.

Rotary Presses

In a rotary letterpress the paper passes between one or more pairs of rotating *cylinders:* (1) the *plate* cylinder with its electrotypes and (2) the *impression* cylinder which presses the paper into contact with the electrotypes. A rotary offset press uses sets of three cylinders: (1) the *plate* cylinder, (2) the *blanket* cylinder which contacts the plate cylinder and receives the inked image from it by transfer and (3) the impression cylinder. In an offset press the blanket cylinder does the printing and the paper never touches the plate cylinder. Since the cylinders in both types of rotary press are geared together and rotate steadily in their given directions (like the rollers in an old fashioned clothes wringer) such a press is capable of very high operating speeds, and especially if the paper is fed continuously from rolls as in the web type. Figure 9 illustrates a newspaper press of this type and clearly shows the paper rolls below the inclosed printing units, each of which prints both sides of a four-page section. Since absolute synchronism among the several units is required, all are driven by a common longitudinal shaft carrying bath-lubricated spiral bevel main drive gears for each unit. Mild extreme pressure lubricants containing lead compounds and other additives are widely used to lubricate such gearing. The cylinder bearings, cylinder drive gears and ink cylinder drives for each unit are all inclosed in oil-tight housings and lubricated by each unit's individual circulating oil system. Unfortunately Figure 9 can not clearly show the distant delivery end of the press which assembles the printed paper webs from the several units, folds, and cuts them into completed newspapers.



Courtesy of R. Hoe & Co., Inc.

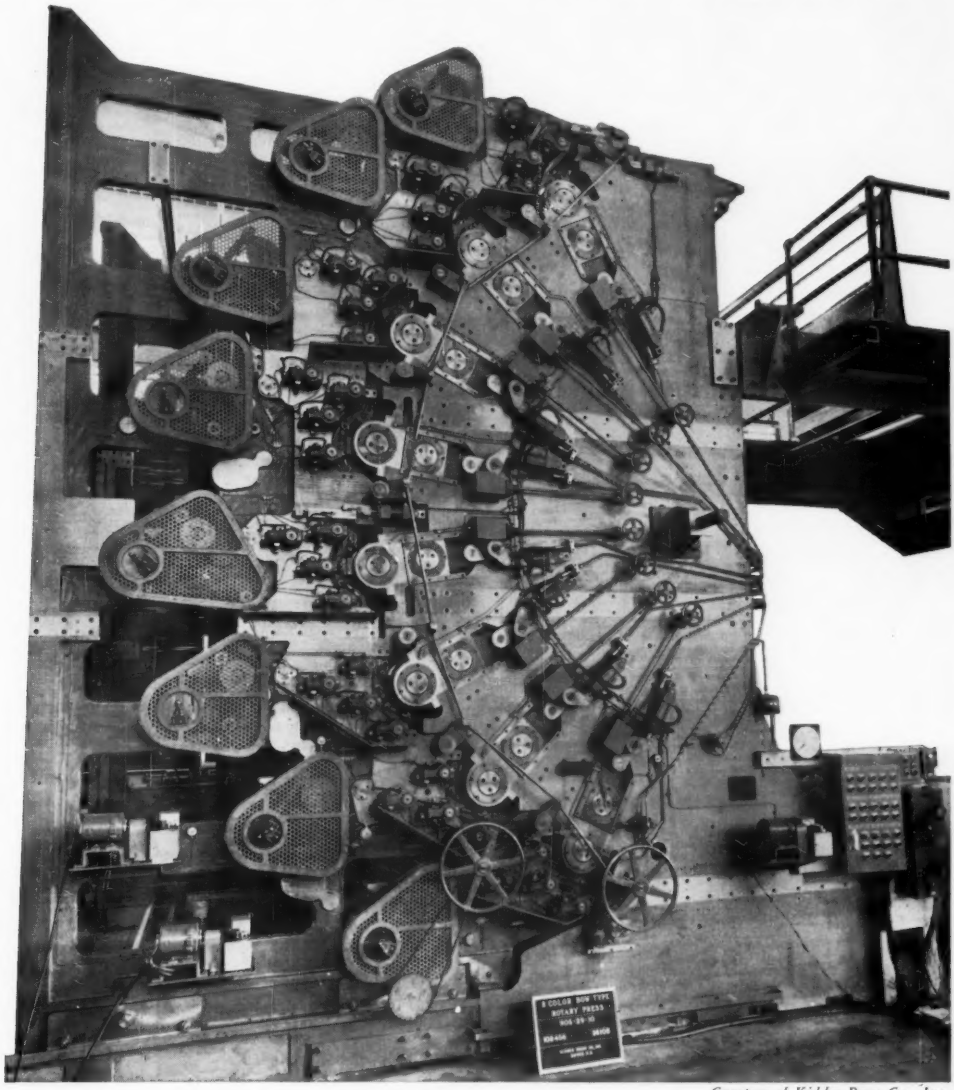
Figure 9 — A large Hoe newspaper press.

Figure 10 presents a very large eight-color web-fed rotary letterpress of the interesting *bow* type. Though the press is shown in its closed or operating position, its entire left hand portion containing the eight sets of inker rolls is readily moved to the reader's left (by means of the left of the two large handwheels) to permit easy access to the eight pairs of printing cylinders. A unique feature of this press is the use of individually controlled hydraulic systems to bring together and maintain controlled pressure on each cylinder pair. As behooves a mechanism of this high order, the press is fitted with a very complete automatic pressure lubricating system; a number of the component lines, distributor blocks and lubricant pumps being readily visible in Figure 10. The hydraulic system utilizes a rust and oxidation-inhibited hydraulic oil having a viscosity of about 150 SUS at 100°F. The pressure lubrication system requires a turbine oil with a viscosity of about 300 SUS at 100°F: the P.I.V. drives need a similar oil with a viscosity of 135 SUS at 210°F. Enclosed gearing is bath-lubricated with a mild extreme pressure lubricant having a viscosity of about 1300 SUS at 100°F. Ball and roller bearings are pressure-lubricated with an NLGI grade 2 ball and roller bearing grease.

Figure 11 presents one of the four retractable two-color inking units in a large modern high speed rotary type web-fed press used to produce a popular weekly magazine by letterpress methods. This press prints both sides of two paper webs, each travelling at 1500 feet per minute to make 30,000 magazines from 64-page signatures or 1,920,000 pages every hour. Air cylinders are used to exert pressure between each plate and its corresponding impression cylinder. The several colors are overprinted wet and steam-fed dryer rolls are employed to dry the webs before slitting, assembling, folding and stitching them into the finished magazines. As might be expected from its complexity and the numerous diverse lubricant requirements, this press employs a combination of many of the previously described lubrication methods including circulating oil systems, oil mist lubrication, oil baths and splash lubrication, centralized hand pressure oil and grease systems, airline lubricators for the air cylinders, and a very minimum of lubrication points requiring hand application of oil or grease at daily or weekly intervals. The multiplicity of oil and grease tubes, distribution blocks and flexible hoses is quite evident in Figure 11, and a tribute to the thoroughness of design.

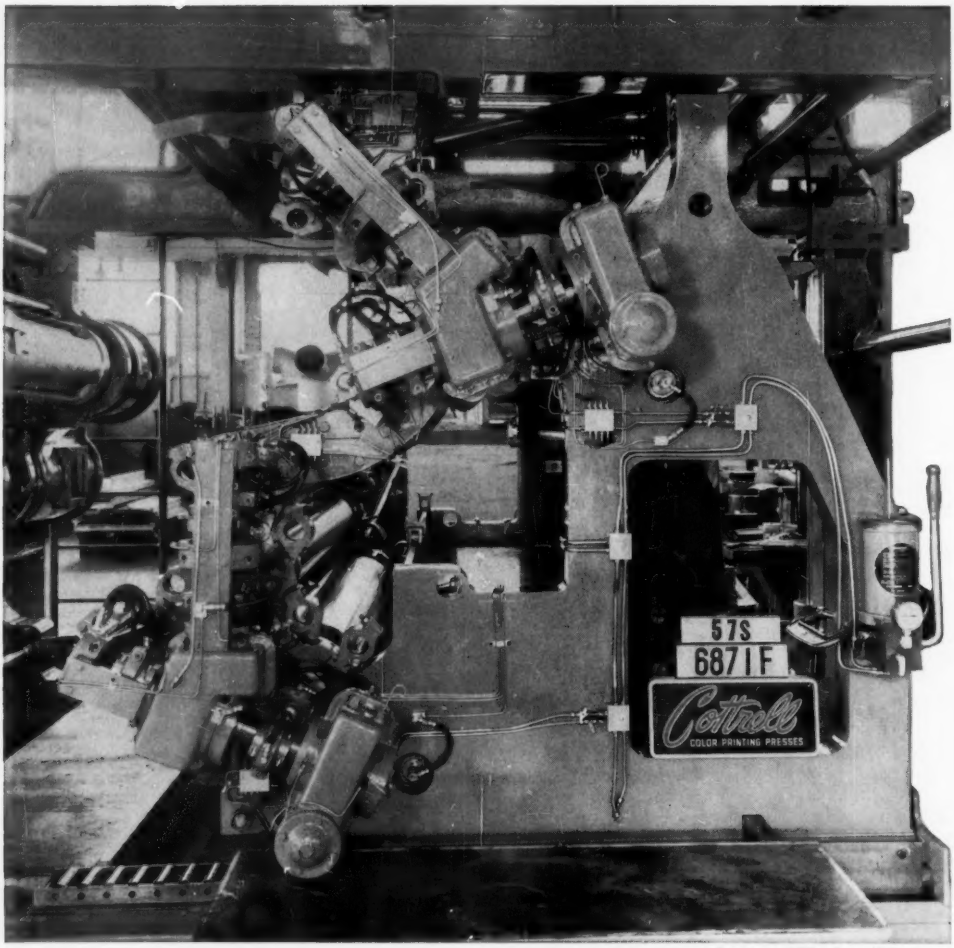
It should be emphasized that the three presses just described are of the rotary web-fed letterpress type. As the following will show the rotary principle is also widely used in high speed lithography or offset printing.

For example Figure 12 illustrates a rotary type sheet-fed *offset* press of a size (18 x 24½") that is widely used in job printing. There are many problems common to both letterpress and offset printing and one of these is the necessity for applying just enough ink – neither too much nor too little – to the printing plate. The circles numbered 1 through 20 in schematic Figure 13 represent the remarkable assembly of rollers that is required just to obtain a thin but uniform layer of ink. As is common to most presses, some of these rollers (numbers 15 and 16 in this instance) oscillate endwise as they rotate and *"form" rollers* (numbers



Courtesy of Kidder Press Co., Inc.

Figure 10 – A large Kidder bow type eight color web-fed rotary letterpress.



Courtesy of The Cottrell Company

Figure 11 — One of the four retractable inker units in a large Cottrell high speed magazine press. Many details of the extensive lubrication system are readily visible.

18, 19, 20) of different diameters are also used. Rollers 22 through 26 are the "dampeners" which apply a thin layer of water to the plate, a requirement peculiar to offset printing.

All the main bearings in this press are lubricated every four hours by means of a centralized hand-pressure oiling system using an oil having a viscosity between 600 and 1000 SUS at 100°F and containing rust and oxidation preventive additives. More and more printing press manufacturers are recognizing the special advantages of oils containing such additives. The manufacturer has thoughtfully painted "oil can" points with red paint to indicate daily application of the same oil. Anti friction and plain bearings are pressure gun lubricated with an NLGI No. 2 ball and roller bearing grease.

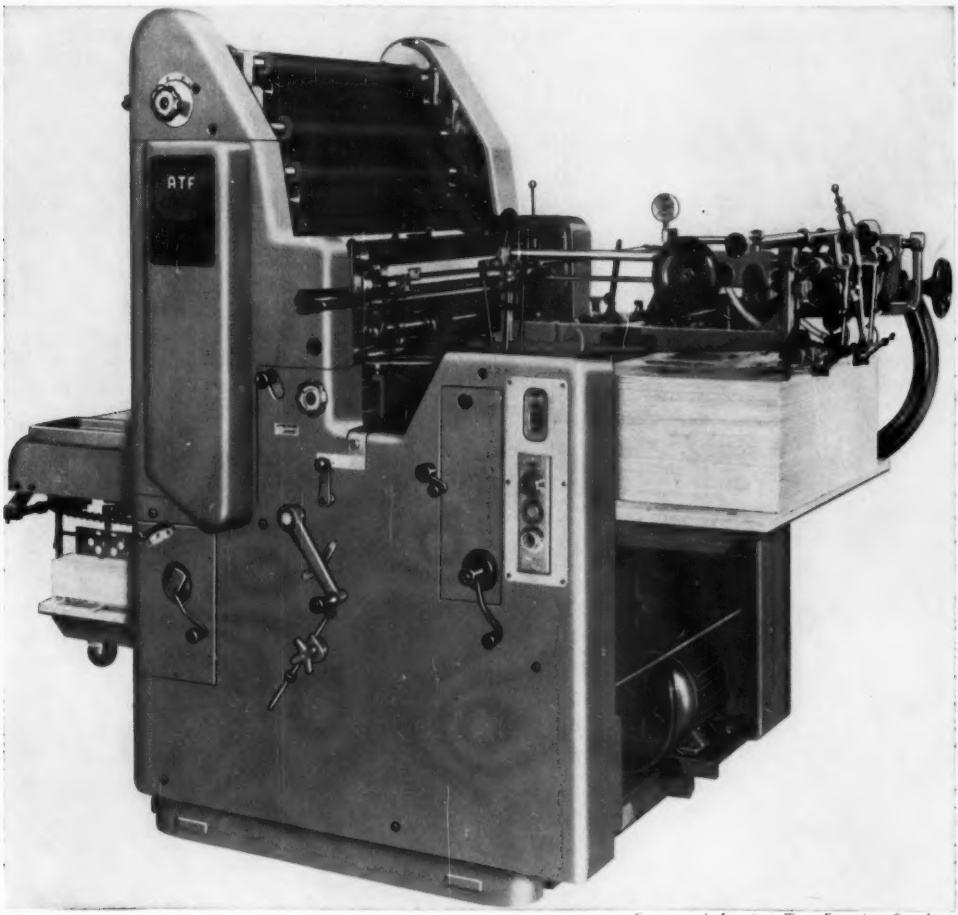
Figure 14 illustrates the feed end of a very large six-color rotary type offset press which handles sheets 52½ x 77". Each of the readily-visible color units is tied into a very complete automatic lubrication system which delivers measured amounts of oil from a central reservoir every two hours (regardless of press speed) to each of the press' more than 500 different lubrication points. As a consequence of the manifold advantages of such a lubrication system — longer press life, maximum safety and dependability, lower lubricant consumption, higher production, better pressroom cleanliness and house-

keeping – the manufacturer now uses a similar system on all his latest presses.

Figure 15 presents a side view of a rotary type six-color sheet-fed offset press which handles 54 x 77″ sheets at speeds of 6000 per hour and is claimed to be the world's largest of its type. Its design has been so carefully worked out that the color units are interchangeable and can be added as required. Such a press prints on board or paper with equal ease and is used to produce a wide variety of labels, catalogs, literature, direct mail advertising, brochures, folding cartons and other containers.

FOLDERS

Some of the foregoing rotary presses contain their own folders, however the flat bed letterpress used to print this publication delivers a large flat printed sheet which requires additional treatment. Figure 16 illustrates a folding machine which is unique in its simplicity, its apparently continuous rather than intermittent operation, and a speed so high that the unaided eye can not count the individuals in the swift stream of product. The sheets are properly placed correct side up on the feed table (at the reader's right) which has the sole but important function of depositing a single sheet at a time without overlapping on a series of tapes and rollers. The tapes and rollers are driven at high speed and the latter are angled so that they crowd and hold each sheet against a longitudinal guide. A "running" longitudinal fold is accomplished by a *plate* which picks up the outer corner of the leading end of the sheet, doubles it over and then creases it as the folded sheet passes under the plate.

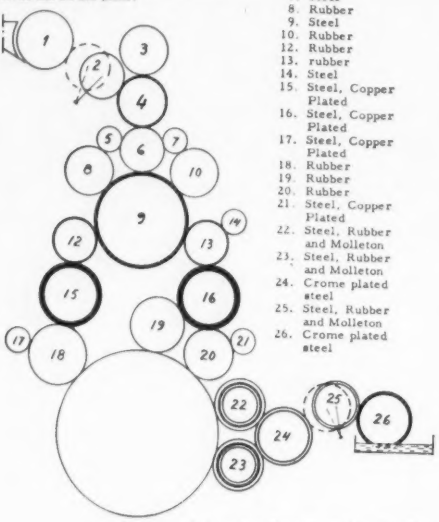


Courtesy of American Type Founders Co., Inc.

Figure 12 – The ATF Chief 24 single color offset press.

The inking system comprises twenty rollers for proper and efficient distribution of ink. The four lower steel rollers are copper plated to prevent oxidation when water is going up into the inking system. The three form rollers have different diameters to ensure uniform distribution of ink on the plate.

1. Steel
2. Rubber
3. Rubber
4. Steel
5. Steel
6. Rubber
7. Steel
8. Rubber
9. Steel
10. Rubber
12. Rubber
13. rubber
14. Steel
15. Steel, Copper Plated
16. Steel, Copper Plated
17. Steel, Copper Plated
18. Rubber
19. Rubber
20. Rubber
21. Steel, Copper Plated
22. Steel, Rubber and Molleton
23. Steel, Rubber and Molleton
24. Crome plated steel
25. Steel, Rubber and Molleton
26. Crome plated steel



Courtesy of American Type Founders Co., Inc.

Figure 13 — Schematic diagram of the ink and water rollers in the ATF Chief 24 single color offset press.

A cross fold is accomplished without turning the sheet by another group of rollers and a plate located at right angles to the first. To avoid trapping air and consequent buckling, a second fold is usually perforated as well. The driving motor, rollers and other parts are hand lubricated periodically with a few drops of light machine oil.

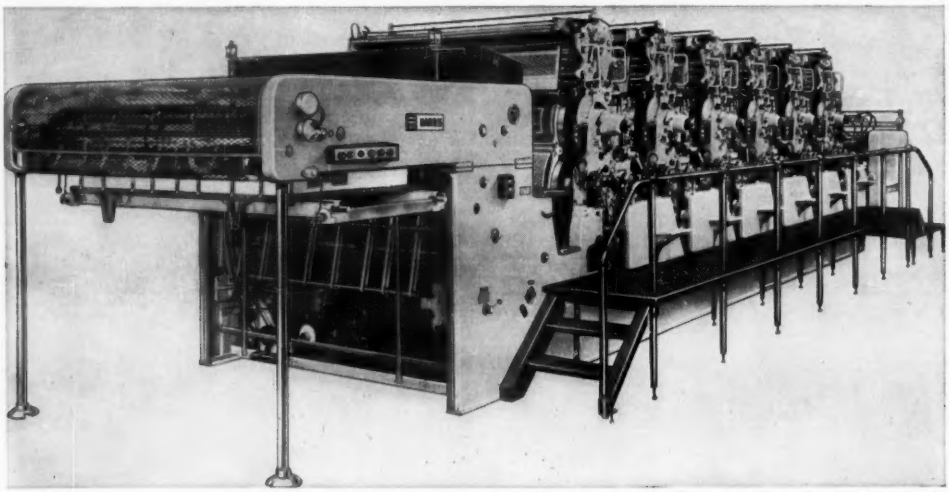
STITCHERS AND TRIMMERS

Any brochure or booklet publication with more than four pages, like this publication, is made up by folding and "stitching" one or more sheets, then trimming off the unwanted side folds with a power operated "guillotine" knife. Figure 17 illustrates such a stitcher which in this publication is used to apply the two wire staples in its center fold. As indicated in the figure the folded sheet (or "signature") is hung by hand on the machine's *rail* where it is propelled under the two *stitcher heads*. These manufacture their staples from the coils of wire at their tops, insert and clinch them, and the product is discharged onto the table at the reader's left. Where two or more signatures must be assembled, a machine with a longer assembly rail is used and separate operators hang their signatures at separate stations, beginning of course with the signature that will form the innermost pages.

The lubrication of this machine is important but relatively simple: two oil cups are filled and all other moving parts lubricated every 40 hours of use with a light machine oil. The gear reduction unit in the machine's main column is kept filled with a grease of NLGI #1 consistency.

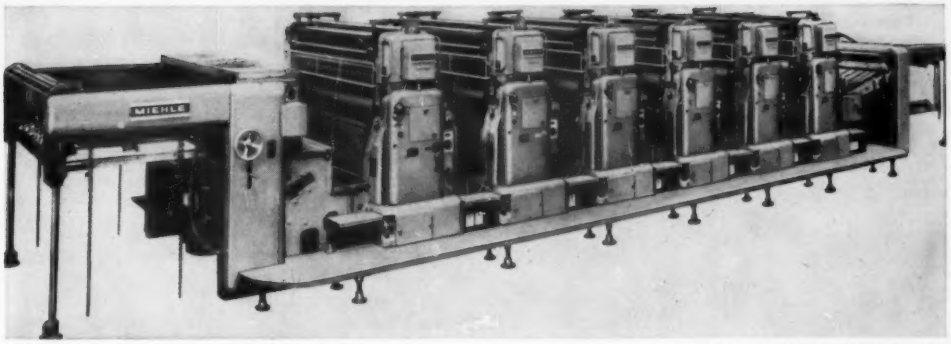
ADDRESSOGRAPH

This highly ingenious machine deserves mention here for two reasons: (1) it is actually a printing press of the letterpress type and (2) it is the widely used final mechanical operation employed to ad-



Courtesy of Harris-Intertype Corporation

Figure 14 — The Harris sheet-fed six-color 52½"x77" offset press.

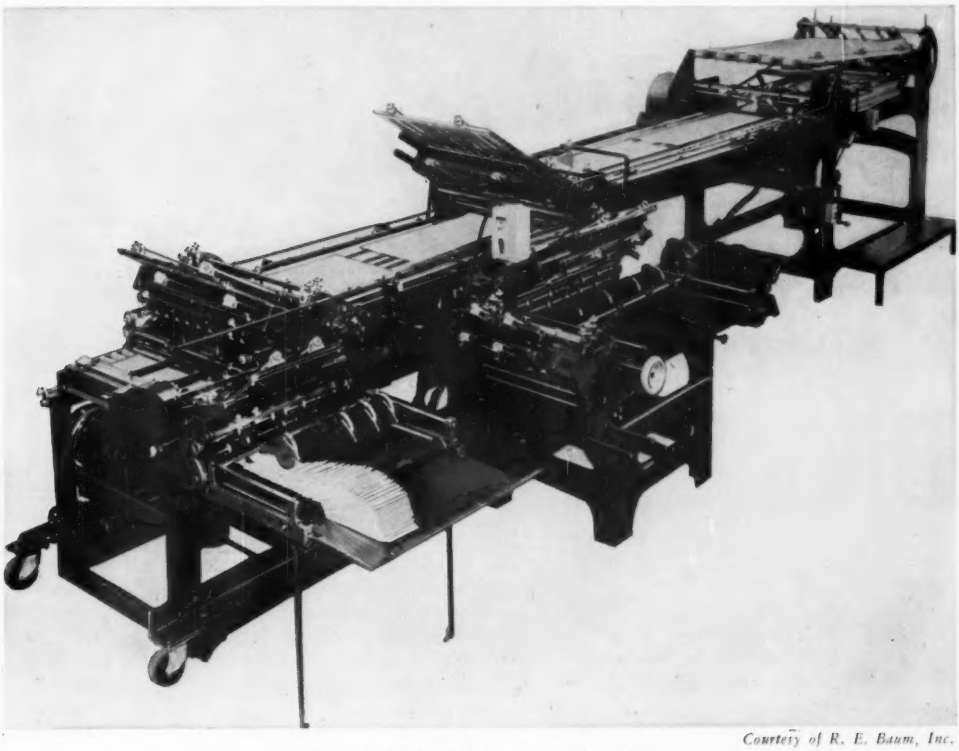


Courtesy of The Miehle Company

Figure 15 — The Miehle 54-77 sheet-fed six-color offset press.

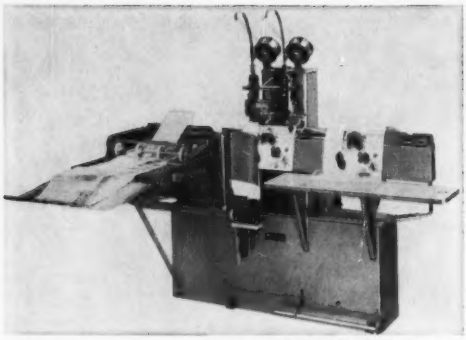
dress the printed publication on its containing envelope and thereby transmit it to the reader.

The distribution "list" for this publication within the United States is actually composed of approximately 41,000 individual metal plates like that shown in Figure 18. The recipient's name and address is embossed on a thin zinc or aluminum plate which inserts and locks into the lower part of the plate frame. The plate imprint card at the top of the frame is only a convenience to the uninitiate and quite superfluous to a trained operator (and printer) who readily reads the reversed lettering of the plate itself. Blank envelopes are stacked on the feed table of the addressograph machine at the reader's right in Figure 19 and backed with a follower board. A half horsepower electric motor



Courtesy of R. E. Baum, Inc.

Figure 16 — A Baum high speed signature folder.



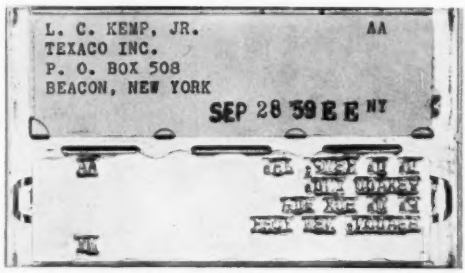
Courtesy of F. P. Rosback Company

Figure 17 — A Rosback Auto-Stitcher.

drives all elements of the machine including a pump from which both a vacuum and air under pressure are obtained and used in the ingenious envelope feed mechanism. A series of driven canvas tapes propel the envelope rapidly along the table, hold it frictionally against the various automatic stops that are interposed and finally deposit it on the discharge pile at the reader's left.

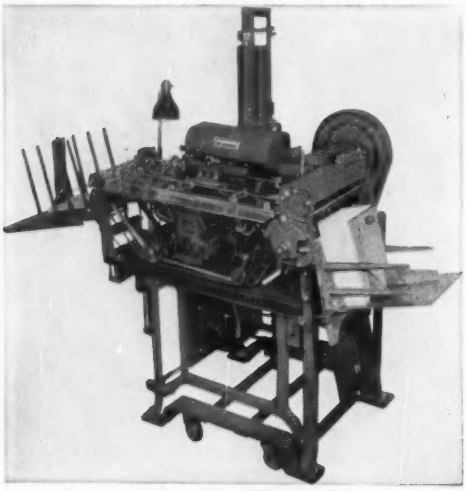
A file drawer of about two hundred of the plates pictured in Figure 18 is emptied into the vertical feeder magazine which shows prominently at the top of Figure 19. The bottom plate is pushed horizontally under the table into its printing position beneath the inking ribbon. The hammer-like *platen* (which appears in the center of the table) then strikes a single firm blow downwards to print the plate through the ribbon onto the envelope in much the same manner as the usual typewriter except that an entire name address is printed with one motion. As each plate is used it is deposited in a chute and eventually returned in the same order to its original file drawer. Numerous attachments are available which adapt the basic machine to multiple operations on each workpiece. Several automatic devices are built into the machine which instantly stop it and signal the operator whenever a misoperation is attempted.

Automatic lubrication of such a complex but compact and lightly-loaded machine is impractical. The manufacturer recommends that each of the several lubrication points including roller chains be oiled once a day with a drop or two of medium weight machine oil, and that any excess or spillage be wiped away to prevent dust collection, spotting of work and soiling of clothing. Though not specifically recommended by the manufacturer, experience has shown that an oil containing special rust and oxidation additives is advantageous, especially when the machine is required to operate in an air-conditioned atmosphere. The vacuum-air pump requires a somewhat more viscous oil while the reduction gear uses a semi-fluid grease.



Courtesy of Addressograph-Multigraph Corp.

Figure 18 — An Addressograph plate assembly consisting of the embossed metal address plate and its corresponding identification card inserted in a metal carrier frame.



Courtesy of Addressograph-Multigraph Corp.

Figure 19 — A class 3400 Addressograph machine.

SUMMARY

Most of this world's ills could be cured with better communications: the most permanent and potentially the most effective method of communicating information is the distribution of printed words and pictures. Unfortunately printed material appears so deceptively simple that the reading public has but little appreciation of the complex methods and machinery required to produce it. This issue has lightly sketched some of the printing industry's complexities and has indicated a few of the many situations in which the petroleum industry is continually assisting it and other industries which supply it with paper, ink, machines, power, light and transportation.

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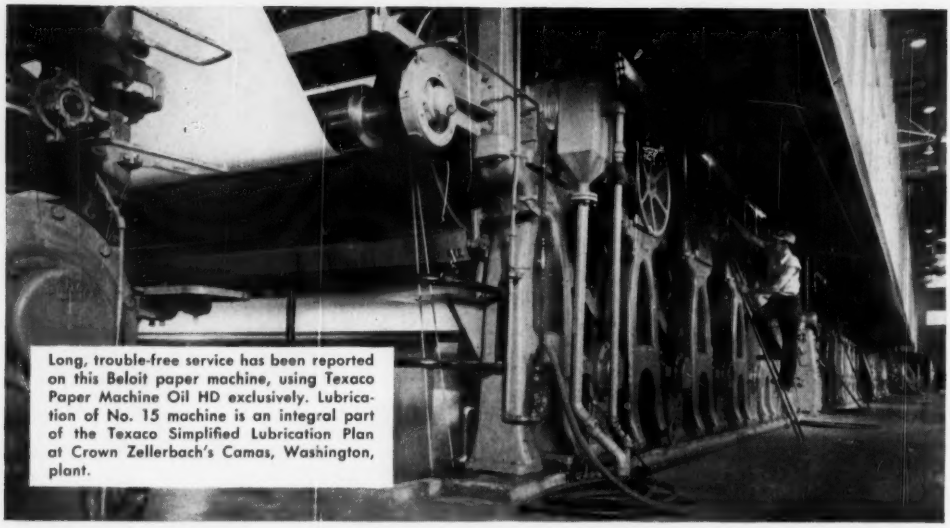

Long, trouble-free service has been reported on this Beloit paper machine, using Texaco Paper Machine Oil HD exclusively. Lubrication of No. 15 machine is an integral part of the Texaco Simplified Lubrication Plan at Crown Zellerbach's Camas, Washington, plant.

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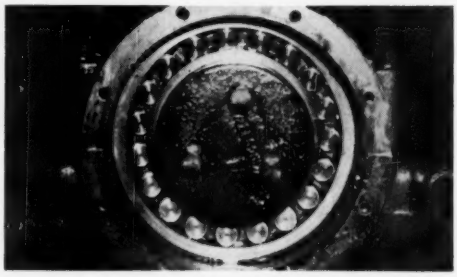
Bearings last longer with Texaco Paper Machine Oil HD because it's designed to circulate freely and lubricate completely even in very hot, wet conditions. Its detergent and dispersive additives keep circulating systems free of carbon, paper dust and sludge, and its fast and easy water-separation insures dependable protection against rust and corrosion.



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